P and T Gas Law - The Gay-Lussac Gas Law

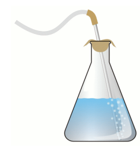
Read from **Lesson 2: Gas Laws** in the **Chemistry Tutorial Section, Chapter 10** of **The Physics Classroom**:
Part a: **Pressure and Temperature**

Joseph Gay-Lussac (a French scientist and balloonist) determined that for a sample of gas with a constant volume and number of moles, the pressure of the gas is directly proportional to its Kelvin temperature. If you keep the volume and amount of gas constant, the pressure of a gas increases linearly with the temperature of the gas (and vice versa).

This proportionality statement is often written in equation form as **P = k•T or** $\frac{P}{T}$ **= k**
where **P** is the pressure measured in atmospheres (atm), kiloPascals (kPa), millimeters mercury (mmHg), and torr, **T** is the Kelvin temperature, and **k** is a proportionality constant.

Part 1: Gay-Lussac Gas Law Lab

Mark Eury and Molly Cule are studying gas laws in the lab. They use a sample of air in an Erlenmeyer flask and place it in different water baths that are at different temperatures. Pressure is measured with a pressure sensor and the temperature is measured with a thermometer. The volume of the air sample and the number of molecules it contains are kept constant. They are trying to determine what kind of mathematical relationship exists between the pressure and absolute temperature of a gas.



1. Fill in the missing data in their data table:

Pressure (kPa)	Temperature (°C)	Temperature (K)	Constant (P / T)
97.0	0.0		
102	15.0		
106	25.0		
109	35.0		
113	45.0		

2. Graph pressure (kPa) vs temperature (K). Use your calculator, Desmos, Excel, Google Sheets, Logger Pro, or another program.
   a. Based on the data and graph for this experiment, describe the relationship between gas pressure and temperature.

   b. Explain how molecular speed and collisions help to explain this relationship?

   c. Find the slope of the best fit line for the data – is the slope of the best fit line similar to the values of the last column in the data table? Should it be? Explain your answer.

   d. According to this experiment, what should happen to the pressure of a gas if the temperature (K) is doubled? Tripled? Halved?

Gases and Gas Laws

Part 2: Gay-Lussac Gas Problems Show all work as you solve these problems.
Example: A gas has a pressure of 0.25 atm at 65°C. If the volume is held constant, what is the new pressure when it cools to 45°C?

First, assign values to the variables in the equation

P_1 = 0.25 atm

T_1 = 65°C +273.15 = 338.15

T_2 = 45°C +273.15 = 318.15

P_2 = ?

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$P_1{*}T_2 = P_2{*}T_1$$

$$(0.25)(318.15) = P_2{*}\ (388.15)$$

$$P_2 = 0.24 \text{ atm}$$

1. The pressure inside a car tire is initially measured to be 198 kPa at a temperature of 27°C. After an extended drive, the pressure rises to 225 kPa. Determine the air temperature in the tire after the drive.

   P_1 =

   T_1 =

   T_2 =

   P_2 =

2. 2. A weather balloon floats at an altitude of 38,000 meters where its temperature is -56.5°C and atmospheric pressure inside the balloon is 0.192 atm. Assuming constant volume and number of particles, what is the new pressure inside the balloon when it returns to a lower altitude and temperature of 15°C.

   P_1 =

   T_1 =

   T_2 =

   P_2 =

3. A gas has a pressure of 999.0 mmHg at 35.0°C. What is the temperature at standard pressure?

   P_1 =

   T_1 =

   T_2 =

   P_2 =